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Regulatory

File Cy-

March 30, 1977

Director of Nuclear Reactor Regulation

Docket Nos. 50-387,
50-388

Attention: Olan D. Parr, Chief
Light Water Reactors Branch No. 3
U.S. Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
MODIFICATION TO CONCRETE SPECIFICATION
ER-100450 FILE 840-2, 150-1
PLA-168

Dear Mr. Parr:

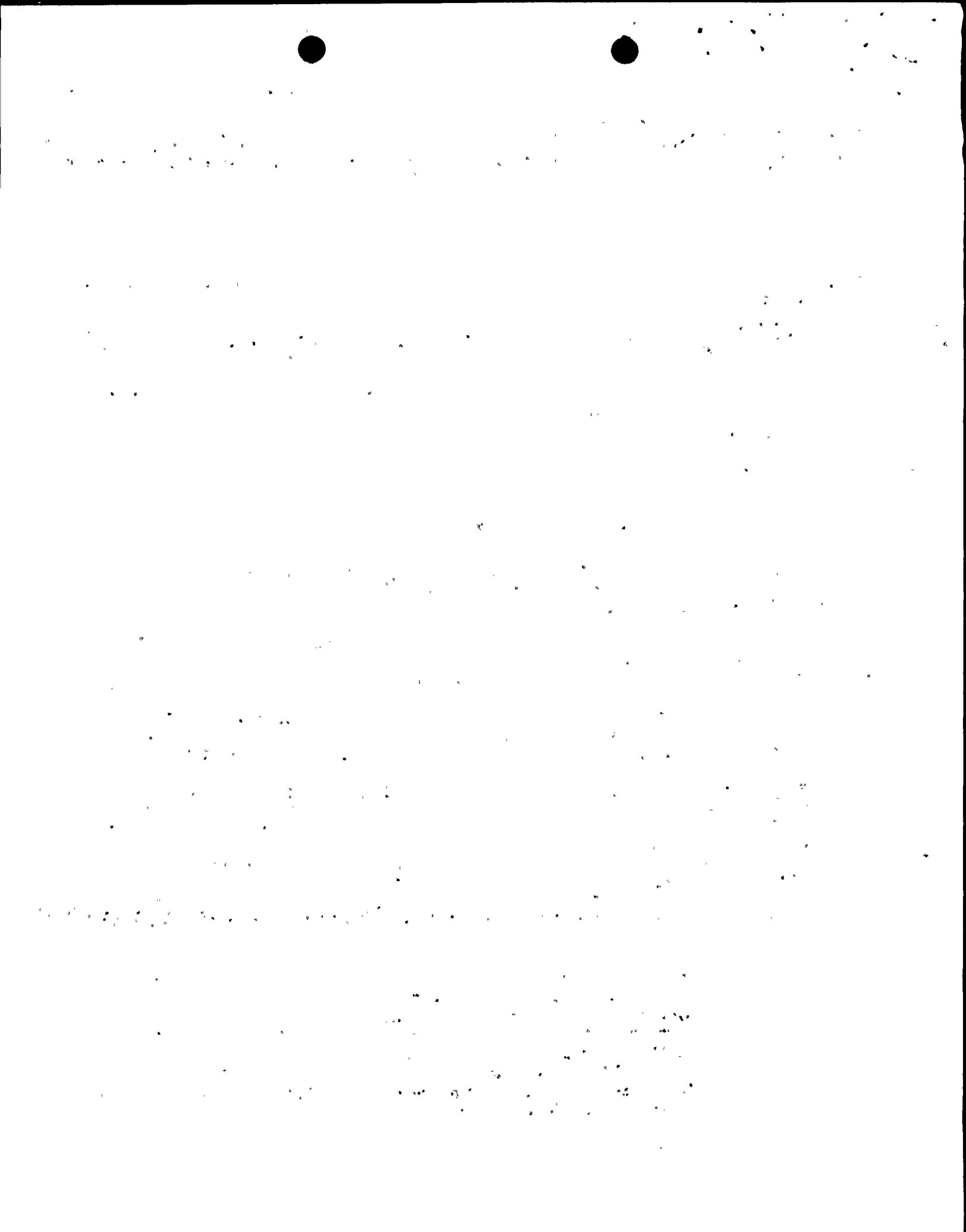
We have reviewed our Susquehanna SES Project concrete requirements with the objective of improving our schedule and cost considerations while retaining a high level of construction quality.

Based on this review, we propose to modify or clarify sections of the following codes: ACI-318-71, ACI-301-72 and ACI-306-66. The following is the proposed change which we intend to implement on June 1, 1977.

PROPOSAL: To reduce the minimum required period of curing and protective measures for concrete members, 2-1/2 feet or less in the least dimension, during cold weather from seven days to three days and the requirements of Table 1.4.2 of ACI 306.

BASIS: ACI curing requirements are established for the reasons cited in ACI 308-71, "Recommended Practice for Curing Concrete" in paragraph 1.2 which states in part:

"Curing is the process of maintaining a satisfactory moisture content and a favorable temperature in concrete during hydration of the cementitious material so that desired properties of the concrete are developed. Curing is essential in the production of quality concrete. The potential strength and durability of concrete will be fully developed only if it is properly cured for an adequate period prior to being placed in service."



To effect curing requirements for cold weather concreting that are reasonable and adequate for this application the Susquehanna project has made the following considerations in arriving at appropriate concrete curing requirements for cold weather concreting.

1. ACI 301-72, paragraph 12.3.1 references ACI 306, "Recommended Practice for Cold Weather Concreting" for detailed recommendations on curing and protection of concrete during cold weather. As this reference appears in a different paragraph (12.3) from that which contains general requirements and reference to 7 days minimum curing (12.2), it is concluded that the recommendations of ACI 306 take precedence over the ACI 301 requirements during periods of cold weather.

Similarly, the ACI 318 requirements for general curing (paragraph 5.5) are separated from cold weather requirements (paragraph 5.6). Although not specifically referenced in paragraph 5.6, ACI 306 is considered more definitive than the minimal discussion contained in ACI 318.

Therefore, it is concluded that the definitive reference for concreting methods during cold weather is ACI 306-66 (1972).

2. ACI 306, paragraph 1.9 states in part:

"Concrete should not be placed at high temperatures. It should always be placed at the lowest allowable temperatures (see Chapter 2). The opportunity provided by cold weather to readily do so should be taken. Concrete which is not allowed to freeze and which is placed at low temperatures above freezing, and receives long-time natural curing develops higher ultimate strength, greater durability, and less thermal cracking than similar concrete placed at higher temperatures. A high..."

ACI 306, paragraph 1.10 states that winter concreting practices must be adequate to:

- i) Prevent damage to the concrete from freezing and thawing at an early age while the concrete is critically saturated. Most well proportioned concrete completes this saturated cycle during the second day.
- ii) Allow concrete to develop sufficient strength to allow safe removal of forms in accordance with Table 1.4.2. Table 1.4.2 indicates 3 days minimum protection are required for both safe strength and durability for concrete containing Type II cement that will be exposed to ambient conditions but will not be subjected to service loads.



- iii) Maintain curing conditions which will foster normal strength development, and without critical saturation and excessive heat at the end of the protection period.
 - iv) Limit rapid temperature changes at the end of the protection period so as not to exceed the value given in Line 17 of Table 1.4.1 in 24 hours.
3. An extensive test program was recently conducted to verify that the specific materials being used on this project, and the mix designs, are producing concrete consistent with the assumptions in ACI 306 that permit a winter curing period as short as two or three days.

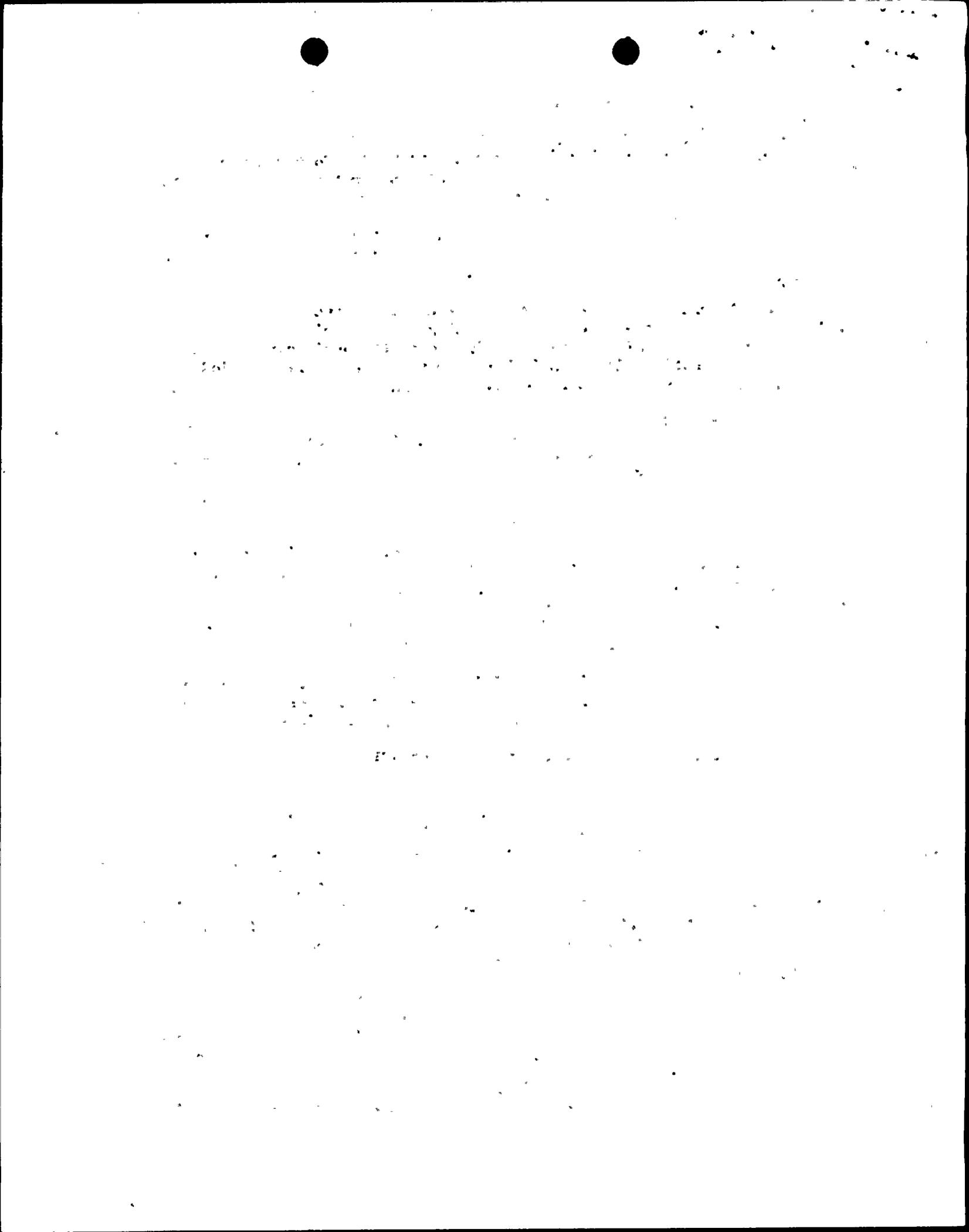
The test program "cured" sets of cylinders for periods from one through seven days at 40F; then froze individual sets of cylinders at the ends of each of these periods, for 24 hours; each set of cylinders was then cured at recommended curing room temperatures for the balance of the standard project curing period.

Several tests were performed on the cylinders, including a petrographic examination, which confirmed that no damage had been caused by the freezing.

The results indicated that after the first day, the 24 hours of freezing did not harm the concrete.

The "curing" at 40F slowed down the development of strength, thus confirming the validity of the variable curing periods in Table 1.4.2 based on service (loading) conditions.

4. The cold weather recommendations of ACI 306 are implemented by the following:
- i. Require the concrete surfaces to reach a surface dry condition during a minimum 24-hour period after the conclusion of the minimum protection and initial curing period. The housing, covering, or other protection shall remain in place during this 24-hour period and shall be maintained in a manner to preclude surface freezing while the surfaces are moist and to preclude a surface temperature gradual drop exceeding 30 F in any 24-hour period prior to or within one hour of removing the protection.
 - ii. Require a minimum protection and initial curing period of 3 days for members 2-1/2 feet or less in the least dimension. The requirements for form removal during cold weather are as required by Specification 8856-C-8, Section 6.4.



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We would appreciate your comments and approval of this procedure prior to June 1, 1977.

Very truly yours,

NW Curtis

Norman W. Curtis

Vice President-Engineering and Construction

Sworn to and subscribed before me
this 6th of April, 1977.

David M. Landes

Notary Public

My Commission expires March 15, 1980

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